University of Pennsylvania

ScholarlyCommons

Wharton Pension Research Council Working Papers

Wharton Pension Research Council

6-2015

Financial Knowledge and 401(k) Investment Performance: A Case Study

Robert Clark
North Carolina State University, robert_clark@ncsu.edu

Olivia S. Mitchell
The Wharton School, University of Pennsylvania, mitchelo@wharton.upenn.edu

Annamaria Lusardi
The George Washington University School of Business, alusardi@gwu.edu

Financial Knowledge and 401(k) Investment Performance: A Case Study

Abstract

We explore whether investors who are more financially knowledgeable earn more on their retirement plan investments compared to their less sophisticated counterparts, using a unique new dataset linking administrative data on investment performance and financial knowledge. Results show that the most financially knowledgeable investors: (a) held 18 percentage points more stock than their least knowledgeable counterparts; (b) could anticipate earning 8 basis points per month more in excess returns; (c) had 40% higher portfolio volatility; and (d) held portfolios with about 38% less idiosyncratic risk, as compared to their least savvy counterparts. Our results are qualitatively similar after controlling on observables as well as modeling sample selection. We also examine portfolio changes to assess the potential impact of the financial literacy intervention. Controlling on other factors, those who elected to take the Financial Literacy survey boosted their equity allocations by 66 basis points and their monthly expected excess returns rose by 2.3 basis points; no significant difference in volatility or nonsystematic risk was detected before versus after the survey. While these findings relate to only one firm, we anticipate that they may spur other efforts to enhance financial knowledge in the workplace.

Keywords

401(k), financial knowledge, investments

Disciplines

Economics

Financial Knowledge and 401(k) Investment Performance:
A Case Study

Robert Clark, Annamaria Lusardi, and Olivia S. Mitchell

June 2015

Financial Knowledge and 401(k) Investment Performance:
A Case Study

Abstract

We explore whether investors who are more financially knowledgeable earn more on their retirement plan investments compared to their less sophisticated counterparts, using a unique new dataset linking administrative data on investment performance and financial knowledge. Results show that the most financially knowledgeable investors: (a) held 18 percentage points more stock than their least knowledgeable counterparts; (b) could anticipate earning 8 basis points per month more in excess returns; (c) had 40% higher portfolio volatility; and (d) held portfolios with about 38% less idiosyncratic risk, as compared to their least savvy counterparts. Our results are qualitatively similar after controlling on observables as well as modeling sample selection. We also examine portfolio changes to assess the potential impact of the financial literacy intervention. Controlling on other factors, those who elected to take the Financial Literacy survey boosted their equity allocations by 66 basis points and their monthly expected excess returns rose by 2.3 basis points; no significant difference in volatility or nonsystematic risk was detected before versus after the survey. While these findings relate to only one firm, we anticipate that they may spur other efforts to enhance financial knowledge in the workplace.

Robert L. Clark
Poole College of Management, Box 729
North Carolina State University
Raleigh, NC 27696
(919) 515-4568
Robert_Clark@ncsu.edu

Annamaria Lusardi
The George Washington School of Business
2201 G Street, NW, Suite 450E, Duquès Hall
Washington, DC 20052
alusardi@gwu.edu

Olivia S. Mitchell
The Wharton School, University of Pennsylvania and NBER
3620 Locust Walk, 3000 SH-DH
Philadelphia, PA 19104
(215) 898-0424
mitchelo@wharton.upenn.edu

Financial Knowledge and 401(k) Investment Performance:
A Case Study

Robert Clark, Annamaria Lusardi, and Olivia S. Mitchell

Financially knowledgeable individuals accumulate more retirement wealth, as we found in our recent literature overview (Lusardi and Mitchell, 2014). Nevertheless, since little is known about how this association arises, a further exploration of the mechanism could be relevant to plan sponsors and, possibly, policymakers. For instance, if we could show that financial knowledge enables people to do a better job investing their retirement savings, this could motivate private and public efforts to enhance financial knowledge in the population at large.[1]

In what follows, we examine the link between financial literacy and investment outcomes using a novel dataset linking administrative records on retirement plan investment performance with an employee survey measuring employees' financial knowledge. Since our findings draw from a single firm, our results are suggestive rather than probative. Nevertheless, they do imply that the most financially knowledgeable individuals invest differently and can expect higher returns on their retirement savings. Results show that the most financially knowledgeable investors: (a) held 18 percentage points more stock than their least knowledgeable counterparts; (b) could anticipate earning 8 basis points per month more in excess returns; (c) had 40% higher portfolio volatility; and (d) held portfolios with about 38% less idiosyncratic risk, as compared to their least savvy counterparts. A return advantage due to more equity exposure does, of course,

---

[1] Alternatively, investors might be able to substitute financial advice instead of enhancing their own financial literacy, but few Americans consult financial advisors, lawyers, or accountants for investment help (Bricker et al. 2012; EBRI 2013). Kim, Maurer, and Mitchell (2015) explore the tradeoffs between hiring a financial adviser and investing in on-the-job human capital. Clark, Maki, and Morrill (2014) report most people (62%) get their investment advice from family and relatives rather than trained professional advisors. Of the third of the population that does engage paid advisors, only one-quarter follows the advice given. Calcagno and Monticone (2015) conclude that non-independent advisors fail to offset clients' low levels of financial knowledge, while Collins (2012) reports that financial advice is a complement to, rather than a substitute for, financial knowledge.

imply more portfolio volatility, yet it could also help generate a larger nest egg over a lifetime of retirement saving. It might also produce greater retirement wealth inequality across the most and least sophisticated, consistent with recent theoretical work (Lusardi, Michaud, and Mitchell, 2013).

Prior Research

People who are more financially savvy have been demonstrated to have more retirement wealth (Lusardi and Mitchell 2011a, 2014). Several possible explanations for this observation have been suggested. One is that more financially literate individuals are wealthier because they plan and save more. This has been confirmed empirically in several studies, even after controlling for education, age, sex, marital status, IQ, and other factors (c.f., Behrman et al. 2012; Lusardi and Mitchell, 2007, 2008, 2011a). Another explanation is that more sophisticated investors hold riskier assets, and hence they tend to benefit from higher excess returns. In one study of Dutch respondents' self-reports on stock and mutual fund holdings, van Rooij, Lusardi, and Alessie (2011) did find a positive correlation between financial knowledge and self-reported stockholding. In a dataset from the US American Life Panel, Yoong (2011) again confirmed that the more financially sophisticated were more likely to self-report they held stocks and mutual funds. Nevertheless, neither of those studies had administrative information linking *actual* investment patterns and financial knowledge.

In related research, better-educated households have been found to hold more stock than their less-educated counterparts (Haliassos and Bertaut 1995; Calvet, Campbell, and Sodini 2007; 2009a, b; Calvet and Sodini 2014). Nevertheless, those authors had no information on *financial knowledge*. This is important, since education and financial literacy measure somewhat different things (Behrman et al. 2012). Bodnaruk and Simonov (2014) examined the portfolios of

private mutual fund managers and concluded that financial experts' investment decisions were no better than those of their less-savvy counterparts; here too, however, the dataset used had no direct measures of investors' financial knowledge. Christelis, Jappelli, and Padula (2010) and Jappelli and Padula (2013a,b) found that respondents' mathematics scores in grade school were associated with more stock market participation later in life. Nevertheless, school IQ and math scores are not identical to financial sophistication (Lusardi, Mitchell, and Curto 2010), suggesting that there is room for a new evaluation of financial literacy effects on portfolio investment behaviors.

Yet a different explanation for how financial literacy could contribute to greater wealth accumulation is that sophisticated individuals may earn higher returns on their investments. There are hints of this in the literature: for instance, Deuflhard, Georgarkos, and Inderst (2014) linked saving account returns of Dutch survey respondents to a set of financial literacy questions and to information on bank interest rates. That study concluded that financial knowledge was associated with higher returns on saving accounts; interestingly, some of this impact was attributable to people's willingness to use self-managed online banking. Nevertheless, their dataset lacked information on any more-sophisticated investments.[2] Also in the Netherlands, von Gaudecker (2015) showed that more knowledgeable respondents reported holding more diversified funds; again, however, his analysis relied on self-reported portfolios rather than arguably more accurate administrative records.

Related to this point is the possibility that sophisticated investors could possibly pick less costly mutual funds, thereby enhancing net returns. Grinblatt et al. (2013) examined how Finnish investors' performance tied to measured IQ scores and business education, and they concluded that higher-IQ investors and those with business education did pay lower fund fees. Lab

---

[2] It is unclear whether that evidence is particularly informative about U.S. 401(k) participants, most of whom hold a mix of stocks and bonds in their portfolios.

experiments by Choi, Laibson, and Madrian (2010) reported that people who deemed themselves more financially knowledgeable also selected somewhat lower-fee investment options than their counterparts. In fact, the last set of authors concluded (p. 1408): "mistakes driven by financial illiteracy are the primary source of the demand for high-fee index funds." In a field experiment, Hastings, Mitchell, and Chyn (2011) designed a financial literacy module administered by a Chilean national survey, to examine whether less financially knowledgeable respondents were differentially sensitive to how pension plan fee information was framed. They reported that the less savvy were, in fact, much more sensitive to the way in which fund fees were framed. Moreover, they reported that financial knowledge played an independent role, separate from that of education. This evidence, while suggestive, stopped short of assessing how financial knowledge affected investment performance in retirement plans, net of fees.

A final reason that the more financially sophisticated may be wealthier is that they may select better-diversified investments, thereby being less exposed to nonmarket or idiosyncratic risk. There is only indirect evidence on this point to date. Tang et al. (2010) reported that 401(k) plan participants tended to be *offered* efficient menus of investment funds, but many constructed quite inefficient portfolios given the choices. That study, however, lacked direct information on participants' financial capabilities.

In sum, previous research has been unable to determine directly whether more financially savvy investors accumulate more assets because they manage their retirement investments more effectively than their less-savvy counterparts. In what follows, we evaluate the links between financial knowledge, investment behavior, and investment performance, using a new employer-based administrative data linked to survey evidence.

Data and Methods

Under confidentiality conditions, we gained access to a unique dataset from the Office of Employee Benefits of the Federal Reserve System (OEB Fed) which has multiple locations across the U.S. The Fed offers its employees a defined benefit (DB) plan of the conventional variety. In addition, it has a DC pension with a fund menu that includes stock and bond index choices, target date funds, lifestyle funds (conservative, moderate, aggressive), international and emerging market funds, and a real estate fund. The OEB Fed provided us with administrative records on each employee's contributions and investment allocations across the DC plan fund menu, which we then linked to fund returns data as detailed below.

Accordingly, we were able to learn which of the funds offered by the plan sponsor each participant selected at two points in time, and what each participant earned on his individual retirement portfolio.[3] Using this linkage and a decade of historical net returns for each fund in the employer's investment menu, we have compute each participant's equity allocation and own portfolio performance metrics as of April and December 2013. Additionally, in cooperation with the OEB, we fielded an internet survey on financial knowledge via email in October of 2013. Responses to this survey were then linked to the administrative records on respondents' investment allocations immediately prior to and after the survey, along with controls for respondents' personal characteristics (sex, age, marital status, job tenure, salary, and 401(k) plan balances).[4] Next we turn to an overview of the dataset and our analysis methods.

A. The Financial Literacy Survey

The Institution's employee benefits office distributed to approximately 16,000 active employees an online survey on financial literacy (FinLit), followed by a short informational

---

[3] All fund returns are reported net of fees; we lack information on the gross returns earned by the investors.
[4] The dataset lacks information on employees' outside investments, but for most, their DB pension is likely their most substantial asset. In the empirical analysis below, we proxy DB plan accruals with controls for age, salary, and tenure in the models below.

webinar explaining key aspects of the firm's retirement saving plan.[5] About 17% of the active

workforce responded to the invitation to take the survey, a response rate similar to other

voluntary and non-incentivized surveys.[6] Our respondent sample differs from the non-respondent

sample in some unsurprising ways: for instance, Table 1 shows that FinLit survey respondents

contributed 1.7 percentage points more of their pretax salaries; had significantly higher plan

balances of almost $100,000; held about two percentage points more equity; were about five

years older; and had worked for the Fed about four years longer than their counterparts. To the

extent that FinLit survey participants were more financially sophisticated than those who did not,

the effects we report below may underestimate the extent to which the entire workforce could

benefit from additional financial education.

Table 1 here

We measured respondents' financial knowledge in the online FinLit survey using five

questions we have developed and field-tested in prior research (correct answers are provided in

bold):

- **Interest Rate:** Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? ***More than $110****, Exactly $110, Less than $110, DK, RF.*[7]
- **Inflation:** Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? *More than today, Exactly the same , **Less than today**, DK, RF*
- **Risk:** Is this statement True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund. *True, **False**, DK, RF*
- **Tax Offset:** Assume you were in the 25 percent tax bracket (you pay $0.25 in tax for each dollar earned) and you contributed $100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then: *Decline by $100, **Decline by $75**, Decline by $50, Remain the same, DK, RF*

---

[5] The webinar was designed to raise awareness of the importance of preparing for retirement and target retirement income needs, and to highlight attributes and benefits of the company's retirement benefit options.

[6] This response rate is in line with what is found in many other online, non-mandatory, and non-incentivized surveys (c.f., Clark, Maki, and Morrill(2014); Constant Contact http://support2.constantcontact.com/articles/FAQ/2344; Benchmark http://www.benchmarkemail.com/help-FAQ/answer/what-is-a-typical-survey-response-rate; Surveygizmo, http://www.surveygizmo.com/survey-blog/survey-response-rates/).

[7] DK refers to "do not know" and RF refers to "refuse to answer."

- **Match:** Assume that an employer matched employee contributions dollar for dollar. If the employee contributed $100 to the 401(k) plan, his account balance in the plan including his contribution would: *Increase by $50, Increase by $100,* ***Increase by $200****, Remain the same , DK, RF*

The first three questions, devised by Lusardi and Mitchell (2008; 2011a), are known as "the Big Three."[8] The first measures people's ability to do a simple interest rate calculation; the second tests people's understanding of inflation; and the third is a joint test of knowledge about "stocks" and "stock mutual funds" as well as risk diversification, since the correct response requires the respondent to know what a stock is and that a mutual fund is comprised of many stocks.

Our prior research has demonstrated that few Americans can answer all of the first three questions correctly (with similar results in other countries), and not many more know the correct answers to two of them. By contrast, this firm's workforce proved to be substantially more financially knowledgeable (as measured by the Big Three) compared to the general population, a predictable result given that the group consists of financial sector employees (see Table 2). Specifically, 76 percent of the respondents responded correctly to the Interest Rate question, 92 percent to the Inflation question, and 88 percent to the Risk question. This can be compared to 75 percent, 61 percent, and 48 percent correct answers in the nationally representative 2012 National Financial Capability Study, which is also an online survey (FINRA Investor Education Foundation, 2013).[9]

Table 2 here

The last two questions were devised and implemented in surveys fielded in large U.S. firms by Clark, Maki and Morrill (2014). Answering these questions proved more difficult, even

---

[8] These questions have also been adopted by many other United States surveys including the National Longitudinal Survey of Youth, the American Life Panel, and the US National Financial Capability Study (Lusardi, Mitchell and Curto, 2010; Lusardi and Mitchell, 2009; Lusardi, 2011); they have also been fielded in 12 other countries (Lusardi and Mitchell, 2011c, 2014); and most recently have been included in the OECD's PISA study.
[9] The 2012 FINRA findings are available at
http://www.usfinancialcapability.org/downloads/NFCS_2012_Report_Natl_Findings.pdf

for this relatively sophisticated group. Both queries required respondents to understand how employer and employee contributions influence retirement plan accumulations, taking into account the tax implications of worker pre-tax contributions. In the Tax Offset question, for instance, the employee had to understand that the tax-deferred aspect of his own contributions reduced the net cost of payments into the plan: only 45 percent of respondents answered this item correctly. The Match question required the employee to know that a dollar-for-dollar match meant that $100 of own contributions would generate an equal employer contribution; moreover employer match dollars are not taxed when contributed to the plan. The Match question was easier to answer for this group, and 78 percent answered this question correctly.

As is conventional,[10] we sum the correct answers to all of the questions to produce a FinLit Index for each person. In this sample, the Index values ranged from 0 to 5, with a mean of 3.8 and a standard deviation of 1.2. One-third of the respondents answered all five questions correctly, while fewer than two percent (46 respondents) got all questions wrong.

B. Investment Metrics

The Fed includes 16 mutual funds in its 401(k) plan including a government securities fund, a TIPS fund, several bond funds, several equity funds, and a REIT Index Fund. Table 3 summarizes descriptive statistics regarding monthly fund returns (net of expenses, measured over the 10-year period ending in April 2013) and asset allocation patterns. The first two columns show that, over this period, bond funds generally earned returns below those of the equity and REIT funds, and they also generally experienced lower volatility.

Table 3 here

The next four columns report the share of assets held by employees in April of 2013, prior to responding to the financial literacy module, along with results sorted by their FinLit

---

[10] As demonstrated by Behrman et al. (2012), generating an index by summing correct answers works just as well as an index generated using more complex principal components methods.

Index scores (the number of correct answers to the survey). Interestingly, the least knowledgeable employees were substantially less likely to hold equity index, international equity, and small company equity funds. And when they did invest in stock funds, they were more likely to invest in the conservative asset allocation fund. Overall, the less savvy were much more likely to be holding bonds than not. Conversely, the more financially sophisticated employees held 17 percentage points or close to 40% (39.9%=(59.6-42.6)/42.6)) more of their assets in equity, compared to the least financially sophisticated group.[11]

To analyze the results in more detail, we have generated four measures to evaluate participants' investment behavior and performance across the firm's DC plan options (all as of April 2013 before the financial literacy survey was conducted). First, we computed the *equity fraction* in participants' retirement portfolios. While financial sophistication need not imply that savvier participants hold more equity, we wish to test whether more knowledgeable individuals did in fact invest more in equities, controlling for other factors (to be described below).

Second, we computed participants' monthly *expected excess returns* r_j^e, using each participant *j*'s contribution allocations to the available funds on offer in month *t*. To do so, we estimate a 6-factor model for all the funds *i=1,...,I* using net return data for the 60 months (*t*-60 to *t*-1) prior to contribution month *t:*

$$\tilde{R}_{it} - R_{Ft} = \alpha + \beta_1(\tilde{R}_{Mt} - R_{Ft}) + \beta_2 SmB_t + \beta_3 HmL_t + \beta_4 WmL_t + \beta_5 Term_t + \beta_6 Def_t + \tilde{e}_{it} \tag{1}$$

Following Fama and French (1993), here $\tilde{R}_{it} - R_{Ft}$ refers to the excess return of fund *i* over the risk-free rate (the one-month Treasury bill rate from Ibbotson Associates); $\tilde{R}_{Mt} - R_{Ft}$ refers to the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from the Center for

---

[11] The equity allocation refers to the fraction of contributions directed to US equity funds, international equity funds, and a percentage of balance/lifecycle funds. The equity percentage for balanced/target date funds is calculated based on each fund's investment policy which varied from fund to fund.

Research in Security Prices, CRSP) minus the risk-free rate; *SmB* refers to the difference in the performance of small relative to big stocks; *HmL* to the difference in performance of value stocks to growth stocks; *WmL* is the Fama-French up-minus-down factor; *Term* measures the difference between the return on a market portfolio of long-term corporate bonds (the composite portfolio in the corporate bond module of Ibbotson Associates) and the one-month Treasury bill rate measured at the end of the previous month (from CRSP); and *Def* measures the difference between the monthly long-term government bond return (from Ibbotson Associates) and the one-month Treasury bill rate measured at the end of the previous month (from CRSP).

Next we used the estimated coefficients from equation (1) and multiplied these by the average values of the respective factors over the prior 60 months (called $\bar{f}_{kt}$ for k=1,…,6):

$$r_i^e = E(R)_{it+1} - F_{Ft+1} = \hat{\alpha} + \hat{\beta}_1(\bar{f}_1) + \hat{\beta}_2(\bar{f}_2) + \hat{\beta}_3(\bar{f}_3) + \hat{\beta}_4(\bar{f}_4) + \hat{\beta}_5(\bar{f}_5) + \hat{\beta}_6(\bar{f}_6) \quad (2')$$

This approach assumes that investors could expect the future paths of each factor to track their historical averages. The systematic return associated with the *i*th fund is then its factor exposure times the average factor returns for that factor. Finally, to generate each participant's expected excess return for fund *i*, we computed:

$$r_j^e = \sum_{i=1}^{I} \omega_{i,t} r_i^e \quad (3)$$

where $\omega_{i,t}$ is the weight of the *i*th fund in the *j*th participant's contributions in month *t*. We also report the *standard deviation of participants' expected excess returns* derived from these computations.

Our fourth performance measure examines how much of the participant's portfolio variance can be attributed to non-systematic (or idiosyncratic) risk. Following Calvet, Campbell,

and Sodini (2007), we used the variance-covariance matrix[12] for all assets, $\hat{\Sigma}$, to estimate the total portfolio variance for the jth participant, $\hat{\Sigma}_j$. This individual portfolio variance can then be decomposed into its systematic and idiosyncratic components as follows:

$$\hat{\Sigma}_j = \omega_{i,t}^{'}\hat{\Sigma}\omega_{i,t} = \omega_{i,t}^{'}(\hat{\Sigma}^{sys} + \hat{D}^{idio})\omega_{i,t} = \hat{\Sigma}_j^{sys} + \hat{\Sigma}_j^{idio} \tag{4}$$

As in Tang et al. (2010), Equation (4) is used to derive *the ratio of the participant's non-systematic risk to his total portfolio variance*, $\%NSR_j = \hat{\Sigma}_j^{idio} / \hat{\Sigma}_j$. The lower is this ratio, the better-diversified is the participant against non-market risk. One could anticipate that the portfolios of the more financially knowledgeable might incorporate lower relative levels of nonsystematic risk.

Information on these four investor performance measures along with the number of funds held by participants prior to the FinLit survey appears in Table 4. In the first column of Panel A we report investment patterns for those who *did not* take the survey. The second column focuses on all those who *did* take the survey, and subsequent columns array outcome measures by respondents' FinLit Index scores. Looking at the first row in Panel A, we see that, on average, nonparticipants held fewer funds compared to those who took the survey, 3.81 versus 4.14, and the difference is statistically significant (Panel B). Moreover, those who answered the survey held 1.62 percentage points more equity resulting in a higher expected monthly return of 2 basis points, 14 basis points higher monthly standard deviation, and no significant difference in nonsystematic risk.

Table 4 here

---

[12] $\hat{\Sigma} = \hat{B}^{'}\hat{\Sigma}_f\hat{B} + \hat{D}$, where $\hat{D}$ is a diagonal matrix with elements computed as the square of the $\hat{\varepsilon}_k$ estimated in equation (1). The asset variance can be decomposed into a portion attributable to systematic risk, $\hat{\Sigma}^{sys} = \hat{B}^{'}\hat{\Sigma}_f\hat{B}$, and a second due to idiosyncratic risk $\hat{D}^{idio}$.

The last three columns of Panel A reveal a strong positive relationship between financial literacy and allocation to equity. That is, participants who scored the lowest on the FinLit Index had the smallest proportion of their portfolios allocated to stocks (44.30 percentage points), whereas the most sophisticated held over 40% more equity (the difference in Panel B of 42.2%=(62.99-44.30)/44.30 is statistically significant at the 1% level). This accounts for the finding in the second row, namely that the sophisticated group averaged a monthly 8 basis points higher expected excess return, compared to the least knowledgeable employees (the difference of 17.4%=(0.54-0.46)/0.46 is significant at the 1% level).[13]

Our finding is thus supportive of Calvet, Campbell, and Sodini's (2007) surmise that higher expected returns are positively correlated with financial sophistication (though that study lacked direct measures of financial knowledge). Patterns of standard deviations correspond to the greater equity holdings: that is, standard deviations are larger (by almost 40%) for the most versus the least knowledgeable (39.6%=(4.23-3.03)/3.03). It is also worth noting that the portfolios held by the most sophisticated displayed much less idiosyncratic risk, 7.51 percentage points, versus the least-savvy respondents, 12.03 (the 38% difference is significant at the 1% level). In other words, more financially knowledgeable participants hold more equity and anticipate earning higher excess returns with higher volatility, but their portfolios embody less nonsystematic risk than those of their less financially literate peers. Interestingly, the group scoring in the mid-range on the financial literacy test looks like the least savvy group; that is, few differences between them are statistically significant in Panel B at conventional levels. Below we evaluate whether these differences persist after controlling for other factors.

---

[13] This could yield an almost 10% larger retirement fund for the most sophisticated over a 30-year life of contributions versus the least knowledgeable, if the former anticipated a base annual return of 2.51% versus the latter at 2% (see http://illuminations.nctm.org/Activity.aspx?id=3568; of course a higher equity share would also imply more volatility).

A Multivariate Analysis of Participant Portfolios and Financial Literacy

To test whether the findings above are robust to a set of control variables, next we estimate a series of multivariate regression models of the following form:

$$PORTFOLIO_i = c + \alpha FinLit + \beta X_i + \varepsilon_i.$$

Here $PORTFOLIO_i$ refers to the four participant investment outcomes just discussed, i.e., the portfolio equity share, expected excess return, standard deviation, and nonsystematic risk share. In each case, α is the coefficient of interest on the FinLit Index. Results shown in Table 5 differentiate the three knowledge groups (the least knowledgeable group is the reference category, with Index = 0-1; the middle group has Index = 2-3; and the most knowledgeable Index = 4-5) as in Table 4. We also control on participant characteristics including age, sex, whether married, salary (in $10K), plan balance (in $100K), and years of tenure at the institution.[14]

Table5 here

A first finding from Table 5 is that, even after including the controls, the most financially knowledgeable plan contributors still held more equity in their portfolios and could expect higher excess returns (and volatility).[15] The FinLit coefficients indicate that the most knowledgeable held 11.52 percentage points more stock than their least knowledgeable counterparts and they could anticipate earning 3.5 basis points per month more in excess returns (versus 18.69 and 8 bps in Table 4, respectively, when no other controls were included). Though the financial literacy effects were slightly smaller than without the control variables, they remain statistically significant and economically large. Indeed, it is remarkable that the strong positive association

---

[14] Descriptive statistics for variables in Table 5 are reported in Appendix Table 1. We also control for region-specific fixed effects and added dummies for missing data. We lack information on respondent education, but income and plan balances are reasonable proxies. We also lack risk aversion measures in this dataset, though in other datasets, including the American Life Panel, we find that the correlation between financial literacy and risk aversion is only 0.05 (Brown, Kapteyn, and Mitchell 2013).

[15] An alternative formulation using dummy variables for age and tenure appears in Appendix Table 2. Results are similar.

between excess returns and the financial index remains, even after netting out past investment success (since we control on respondents' 401(k) balances) and fees (since we use net returns).[16]

Due in part to their higher equity fraction, the portfolios of the most financially knowledgeable were also more volatile, by 70 basis points, compared to the least knowledgeable (versus 1.2 without controls, from Table 4). Nevertheless, portfolios of the savvier group exhibited a statistically significant 1.71 percentage points less idiosyncratic risk (versus -4.52 without controls, in Table 4). In other words, despite adding controls for key demographics and fund balances, the most financially sophisticated still held more equity and diversified their investment portfolios more efficiently, compared to their unsophisticated peers.

Additional Findings

We have established that those who subsequently responded to the financial knowledge survey earned more, held higher plan balances, and contributed more of their salaries to their retirement accounts compared to their non-respondent counterparts. Yet we are aware of the possibility that the observed association between financial knowledge and better investment performance may not be causal. That is, employees who do a poor job investing might be financially illiterate due to some unobservable factor such as IQ or inattention, which could make it difficult to assess whether boosting financial knowledge for those individuals would, in fact, actually enhance their investment outcomes.[17]

Whether the linkage between financial knowledge and returns is larger or smaller when financial knowledge is provided to the entire workforce rather than taken by just a few is

---

[16] We also include the respondents' 401(k) balance as a control variable in the regressions, which weakens any concern about possible reverse causality between returns and financial knowledge. That is, the fact that there remains a positive and statistically significant association between excess returns and the financial index *after netting out past investment success* points to the fact that knowledge drives returns, rather than vice versa.

[17] This point has been extensively discussed by Behrman et al. (2012), and Lusardi and Mitchell (2014).

obviously interesting from a policy perspective. Nevertheless, as we have access only to administrative records rather than results generated by a natural experiment, we are uncertain whether high-financial literacy respondents might differ in some unmeasured but systematic fashion from those who lack this sophistication. This makes it difficult to prove beyond a reasonable doubt that the less sophisticated would benefit from financial education if it were provided to them. An alternative econometric approach would be to use instrumental variables (IV) to control for unobserved factors that might influence portfolio outcomes,[18] but we also lack independent yet correlated variables that we could use to this end.

Instead, we have explored two alternative approaches which we anticipate will diminish potential bias due to sample selection. Table 6 reports results from a Heckman two-step model, where the first column provides estimates of a sample selection equation for those taking the financial literacy survey. The next four columns indicate the estimated impacts of financial literacy on portfolio performance after conditioning on this selection correction; the lambda term, which is the inverse Mills ratio, is constructed from Probit estimates of the first stage. The qualitative impacts of having high financial knowledge are similar, and in some cases ever larger (in absolute value). That is, those scoring high on the FinLit survey had even more equity and a higher expected excess return than without the correction, and the estimated coefficient on the nonsystematic risk share is twice as large (in absolute value) than in Table 5. Accordingly, our conclusions are robust to this correction for sample selection.

Table 6 here

---

[18] Other studies, including Lusardi and Mitchell (2011b), have used IV methods to test for causal effects of financial literacy on retirement planning. Moreover, Bernheim, Garrett, and Maki (2001), Cole and Shastry (2009), and Lusardi and Mitchell (2009) investigate how changes in U.S. schooling laws and state mandates requiring schools to offer financial literacy relate to financial market participation. None of these studies examines how financial literacy relates to investment performance, however.

A different way to handle sample selection is to use a propensity matching model with inverse probability weights. While this approach is less susceptible to misspecification bias (Todd 2014), matching models do assume there is no systematic unobserved difference between those who were "treated" – i.e., financially knowledgeable – versus others. We cannot test this directly in our dataset, but when we use this framework to estimate the impact of financial literacy on portfolio outcomes,[19] we continue to find that the estimated Average Treatment Effect (ATE) of high financial literacy is strongly positive and significant for the equity share, monthly excess returns, and monthly volatility outcomes (see Table 7). Moreover, being in the high financial literacy group is again significantly associated with a lower nonsystematic risk share. The magnitudes of the effects are somewhat smaller for the equity fraction compared to Table 5 (7.1 percentage points instead of 11.5), and for the monthly excess return (3.3 basis points versus 3.5 in Table 5). The coefficient of high financial literacy nonsystematic risk is also smaller than before (-1.57 versus of -1.71) but still statistically significant and quantitatively large.

Table 7

In sum, across three different model specifications, our results appear quite robust. In particular, the most financially knowledgeable did invest more in equity, and hence they could anticipate higher excess returns, albeit with more volatility, compared to their less savvy counterparts. They also held portfolios that were significantly less exposed to nonsystematic risk. And given that all the retirement funds offered in the plan were low-cost index funds, the reported differences were not due to differential charges on participants' portfolios.

Financial Literacy and Longitudinal Portfolio Changes

---

[19] See Cattaneo (2010) and Austin (2011). We estimate the effect of high financial literacy via inverse-probability weighting using estimated probability weights to correct for the missing data problem arising from the fact that each subject is observed in only one of the potential outcomes.

We are also able to compare changes in portfolio outcomes for a short period before and after the financial literacy survey was administered. To this end, we report in Table 8 the changes in equity allocations, excess returns, volatility, and nonsystematic risk percentages comparing plan members' April and December 2013 holdings.[20] The survey, it will be recalled, took place in October of that year.

Table 8 here

We use the entire sample for this analysis, with a dummy variable indicating who participated in the FinLit survey. Controlling on other factors, we see that those who elected to take survey boosted their equity allocations by 66 basis points (on a mean change of 3.90 percent) and their monthly expected excess returns rose by 2.3 basis points (on a mean of 60 bps). No significant difference in volatility or nonsystematic risk was detected, before and after the FinLit survey.

To further understand the reasons for these outcomes, in Table 9 we report how portfolio factor weightings changed, comparing portfolio allocations before and after the FinLit survey. Conditioning on other factors, participation in the survey was significantly associated with an increased exposure to market risk, a marginally significant rise in the Fama-French UmD factor,[21] and small but statistically significant declines in the exposure to bond term structures[22] and bond default risk.[23] This pattern might be worth tracking over longer time periods to observe whether the changes persist, but additional data are not currently available to do so.

---

[20] The longest time period available for analysis was mid-2014; results are similar to those reported here.

[21] Up minus down factor (see Fama and French 1993).

[22] This is defined as the difference between the monthly long-term government bond return (from Ibbotson Associates) and the one-month Treasury bill rate measured at the end of the previous month (from the Center for Research in Security Prices, CRSP); see Fama and French, 1993.

[23] Def is defined as the difference between the return on a market portfolio of long-term corporate bonds (the Composite portfolio on the corporate bond module of Ibbotson Associates) and the long-term government bond; see Fama and French 1993.

Nevertheless, the main message is that those who took the FinLit survey changed their portfolios afterwards to exhibit less "tilt" toward systematic sources of variation.[24]

Table 9 here

Conclusions

Now that 401(k) plans are the most common form of employer pension in the United States, employees are increasingly being asked to take on responsibility for managing their own retirement savings.[25] Yet recent research indicates that many Americans are financially illiterate, casting doubt on the chances that they will be up to the challenge of managing their own money successfully. Moreover, investors who are more financially savvy also save more and accumulate more retirement wealth than their less-knowledgeable counterparts.

This paper has explored whether this might be due to different investment portfolios, and if so, which particular elements differ across more versus less sophisticated investors. To do so we used high-quality administrative data on participants in a large U.S. 401(k) retirement plan, along with a purpose-built survey on financial knowledge. We found that the most financially knowledgeable investors (a) held 18 percentage points more stock than their least knowledgeable counterparts; (b) could anticipate earning 8 basis points per month more in excess returns; (c) had 40% higher portfolio volatility; but (d) held portfolios with about 38% less idiosyncratic risk, compared to their least savvy counterparts. Our results are qualitatively similar after controlling on observables as well as modeling sample selection. Yet they also select portfolios with lower nonsystematic risk, suggesting that they hold better diversified equity portfolios than

---

[24] This is confirmed in results available on request, using inverse-probability weighting models of the changes in portfolio weightings.

[25] In the 1980's, only 40 percent of U.S. private-sector retirement contributions went to Defined Contribution (DC) pensions; today, over 90 percent of contributions are flowing to DC retirement accounts (see Poterba, Venti, and Wise, 2014).

their less sophisticated counterparts. This finding concords with prior studies showing that, even given an efficient fund menu, some plan participants will select better portfolios than others (Tang et al. 2010). We also examined how the portfolio changed after the financial literacy intervention. Controlling on other factors, those who elected to take survey boosted their equity allocations by 66 basis points and their monthly expected excess returns rose by 2.3 basis points, while no significant difference in volatility or nonsystematic risk was detected before versus after the FinLit survey.

Naturally, since this research reports on only one institution's 401(k) plan, our findings must be supplemented with additional quantitative evidence on the impact of financial literacy interventions. Nevertheless, the fact that more knowledge is associated with better 401(k) retirement plan outcomes is supportive of models that posit differences in financial sophistication as a driver of wealth inequality (e.g., Lusardi, Michaud, and Mitchell 2013). An additional point to consider is that, in our context, the investment choices available for participant investments were relatively few and all were quite inexpensive index funds. By contrast, in companies offering more complex investment menus and even brokerage accounts, the impact of high fees on the least financial knowledgeable could be important.[26] Moreover, such differences in financial sophistication could contribute to growing inequality in retirement outcomes. Undoubtedly, the ability to invest wisely and earn better returns is increasingly important for retirement wellbeing in an aging world.

---

[26] Potential changes in other employer-provided retirement benefits (e.g., health saving and health reimbursement accounts) are also likely to enhance the importance of individually-managed investment decisions, inasmuch as these other accounts also require employees to contribute to and manage their savings.

References

Austin, Peter C. 2011. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. *Multivariate Behavioral Research* 46: 399–424.

Behrman, Jere, Olivia S. Mitchell, Cindy Soo, and David Bravo. 2012. Financial Literacy, Schooling, and Wealth Accumulation. *American Economic Review, Papers and Proceedings*. 102(3): 300–304.

Bernheim, Douglas, Daniel Garrett, and Dean Maki. 2001. Education and Saving: The Long-term Effects of High School Financial Curriculum Mandates. *Journal of Public Economics* 80: 435–565.

Bodnaruk, Andriy and Andrei Simonov. 2014. Do Financial Experts Make Better Investment Decisions? *Journal of Financial Intermediation*. Available online 5 October 2014

Bricker, Jesse, Arthur B. Kennickell, Kevin B. Moore, and John Sabelhaus. 2012. Changes in U.S. Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances." *Federal Reserve Bulletin* June 98(2).

Brown, Jeffrey R., Arie Kapteyn, and Olivia S. Mitchell. 2013. "Framing and Claiming: How Information-Framing Affects Expected Social Security Claiming Behavior." *Journal of Risk and Insurance*. July.

Calcagno, Riccardo and Chiara Monticone. 2015. Financial Literacy and the Demand for Advice. *Journal of Banking & Finance* 50: 363–380

Calvet, Laurent, John Campbell, and Paolo Sodini. 2007. Down or Out: Assessing the Welfare Costs of Household Investment Mistakes. *Journal of Political Economy* 115: 707-747

Calvet, Laurent, John Campbell, and Paolo Sodini. 2009a. Fight or Flight? Portfolio Rebalancing by Individual Investors. *Quarterly Journal of Economics* 301-348.

Calvet, Laurent E., John Campbell, and Paolo Sodini. 2009b. Measuring the Financial Sophistication of Households. *American Economic Review, Papers & Proceedings*. 99:2, 393–398

Calvet, Laurent E. and Paolo Sodini. 2014. Twin Picks: Disentangling the Determinants of Risk-Taking in Household Portfolios. *Journal of Finance*. 69(2): 897-906.

Cattaneo, M. D. 2010. Efficient Semiparametric Estimation of Multi-Valued Treatment Effects Under Ignorability. *Journal of Econometrics* 155: 138–154.

Choi, James, David Laibson, and Brigitte Madrian. 2010. Why Does the Law of One Price Fail? An Experiment on Index Mutual Funds. *Review of Financial Studies* 23 (4): 1405-1432.

Christelis, Dimitris, Tullio Jappelli, and Mario Padula. 2010. Cognitive Abilities and Portfolio Choice. *European Economic Review* 54(1): 18–38.

Clark, Robert, Jennifer A. Maki, and Melinda Sandler Morrill. 2014. Can Simple Informational Nudges Increase Employee Participation in a 401(k) Plan? *Southern Economics Journal* 80(3): 677-701.

Cole, Shawn and Gauri Shastry. 2009. "Smart Money: The Effect of Education, Cognitive Ability, and Financial Literacy on Financial Market Participation." HBS Working Paper 09-071.

Collins, J. Michael. 2012. Financial Advice: A Substitute for Financial Literacy? *Financial Services Review* 21:307-322.

Deuflhard, Florian, Dmitris Georgarakos, and Roman Inderst. 2014. Financial Literacy and Savings Account Returns. Unpublished working paper, Goethe University of Frankfurt.

EBRI. (2013). Few Get Paid Advice – Fewer Take It. *Fast Facts*, July 3: 236.

Fama, Eugene F. and Kenneth R. French. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics* 33: 3-56.

FINRA Investor Education Foundation. 2013. *Financial Capability in the United States. Report of Findings from the 2012 National Financial Capability Study.* http://www.usfinancialcapability.org/downloads/NFCS_2012_Report_Natl_Findings.pdf

Grinblatt, Mark, Matt Keloharju, and Juhani Linnainmaa. 2011. IQ and Stock Market Participation. *Journal of Finance* 66(6): 2121-2164.

Haliassos, Michael and Carol Bertaut. 1995. Why Do So Few Hold Stocks? *The Economic Journal* 105, 1110-1129

Hastings, Justine and Olivia S. Mitchell. 2011. How Financial Literacy and Impatience Shape Retirement Wealth and Investment Behaviors. NBER WP 16740.

Hastings, Justine, Olivia S. Mitchell, and Eric Chyn. 2011. Fees, Framing, and Financial Literacy in the Choice of Pension Managers. In *Financial Literacy: Implications for Retirement Security and the Financial Marketplace*. Eds. Olivia S. Mitchell and Annamaria Lusardi. Oxford: Oxford University Press: 101-115.

Jappelli, Tulio, and Mario Padula. 2013a. Consumption Growth, the Interest Rate, and Financial Literacy. CSEF Working Paper no. 329. University of Naples.

Jappelli, Tullio, and Mario Padula. 2013b. Investment in Financial Literacy and Saving Decisions. *Journal of Banking and Finance* 37: 2779-2792.

Kim, Hugh H, Raimond Maurer, and Olivia S. Mitchell. 2015. Time is Money: Life Cycle Rational Inertia and Delegation of Investment Management. NBER WP 19732.

Lusardi, Annamaria. 2011. Americans' Financial Capability. NBER Working Paper 17103.

Lusardi, Annamaria, Pierre-Carl Michaud, and Olivia S. Mitchell. 2013. Optimal Financial Literacy and Wealth Inequality. NBER Working Paper 18669.

Lusardi, Annamaria, and Olivia S. Mitchell. 2014. The Economic Importance of Financial Literacy: Theory and Evidence. *Journal of Economic Literature* 52(1): 5-44

Lusardi, Annamaria, and Olivia S. Mitchell. 2011a. Financial Literacy and Planning: Implications for Retirement Wellbeing. In *Financial Literacy: Implications for Retirement Security and the Financial Marketplace*. Eds. O. S. Mitchell and A. Lusardi. Oxford, Oxford University Press: 17-39.

Lusardi, Annamaria and Olivia S. Mitchell. 2011b. Financial Literacy and Retirement Planning in the United States. *Journal of Pension Economics and Finance* 10(4): 509-525.

Lusardi, Annamaria and Olivia S. Mitchell. 2011c. Financial Literacy around the World: An Overview. *Journal of Pension Economics and Finance* 10(4): 497-508.

Lusardi, Annamaria, and Olivia S. Mitchell. 2009. How Ordinary Consumers Make Complex Economic Decisions: Financial Literacy and Retirement Readiness. NBER Working Paper 15350

Lusardi, Annamaria and Olivia S. Mitchell. 2008. Planning and Financial Literacy: How Do Women Fare? *American Economic Review* 98:2, 413–417.

Lusardi, Annamaria, and Olivia S. Mitchell. 2007. Baby Boomer Retirement Security: The Roles of Planning, Financial literacy, and Housing Wealth. *Journal of Monetary Economics*, 54(1): 205–224.

Lusardi, Annamaria, Olivia S. Mitchell, and Vilsa Curto. 2010. Financial Literacy among the Young. *Journal of Consumer Affairs* 44(2): 358-380.

Poterba, James, Steven Venti, and David Wise. 2014. Health, Education, and the Post-Retirement Evolution of Household Assets. *Journal of Human Capital* 4.

Tang, Ning, Olivia S. Mitchell, Gary Mottola, and Steve Utkus. 2010. The Efficiency of Sponsor and Participant Portfolio Choices in 401(k) Plans. *Journal of Public Economics* 94: 1073-1085.

Todd, Petra E. 2014. *Advanced Microeconometric Techniques and Applications*. Unpublished manuscript, University of Pennsylvania.

van Rooij, Maarten, Annamaria Lusardi, and Rob Alessie. 2011. Financial Literacy and Stock Market Participation. *Journal of Financial Economics* 101(2): 449–472.

von Gaudecker, Hans-Martin. 2015. How Does Household Portfolio Diversification Vary with Financial Sophistication and Advice? *Journal of Finance*. 70(2): 489-507.

Yoong, Joanne. 2011. Financial Illiteracy and Stock Market Participation: Evidence from the RAND American Life Panel. In *Financial Literacy: Implications for Retirement Security and the Financial Marketplace.* Eds O. S. Mitchell and A. Lusardi. Oxford: Oxford University Press: 76-97.

Table 1. Comparison of Characteristics for Survey Respondents and Nonrespondents
This Table summarizes key variables for 401(k) plan participants who did and did not take the Financial Literacy survey. All data derived from the Fed's administrative records and refer to active employees (i.e., not retired, vested terminated, or deceased).

Variable	Nonrespondents	Respondents	Diff. (Nonpart.- Part.)	T-test for significance
% Participants in Pretax Account	1.00	1.00	0.00	
% Salary Contribution Pretax	7.98	9.65	-1.67	***
Total balance ($100k)	1.52	2.47	-0.96	***
% Balance in equity	57.17	59.30	-2.13	***
% Contribution in equity	58.99	61.35	-2.35	***
Age	43.65	48.66	-5.02	***
Male	0.56	0.57	-0.01	
Married	0.63	0.70	-0.07	***
Salary ($10k)	10.28	10.95	-0.07	***
Tenure (years)	10.25	14.15	-3.90	***
N	13,547	2,763		

Note: *** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Table 2. Results of Financial Literacy Assessment
This Table summarizes responses to the five-item Financial Literacy questions by survey respondents. Correct answers are bolded. N=2,763.

A. Responses by Question

Financial Literacy Questions:	Mean	SD
Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? *More than $110, Exactly $110, Less than $110, DK, RF*	0.76	*0.42*
Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? *More than today, Exactly the same , Less than today, DK, RF*	0.92	*0.27*
True or False? Buying a single company's stock usually provides a safer return than a stock mutual fund. *True, False, DK, RF*	0.87	*0.33*
Assume you were in the 25% tax bracket (you pay $0.25 in tax for each dollar earned) and you contributed $100 pretax to an employer's 401(k) plan. Your take-home pay (what's in your paycheck after all taxes and other payments are taken out) will then: *Decline by $100, Decline by $75, Decline by $50, Remain the same, DK, RF*	0.45	*0.50*
Assume that an employer matched employee contributions dollar for dollar. If the employee contributed $100 to the 401(k) plan, his account balance in the plan including his contribution would: *Increase by $50, Increase by $100, Increase by $200, Remain the same DK DK, RF*	0.77	*0.42*
Financial Knowledge Index (# of questions answered correctly)	3.79	*1.19*

B. Distribution of Financial Literacy Index*

FinLit Score	Freq.	Percent (%)
0	44	1.63
1	88	3.25
2	253	9.35
3	525	19.4
4	897	33.15
5	899	33.22
Total	2,706	100.0

*Number of financial literacy questions answered correctly.

Table 3. Fund Returns and Participant Assets by Fund

This Table summarizes monthly returns and standard deviations by fund; it also reports asset allocation patterns for participants who responded to the Financial Literacy survey and contributed to the 401(k) plan. The Financial Literacy Index is derived from summing correct answers to questions in Table 2. The monthly mean return (Std. dev.) refers to each fund's mean monthly return (standard deviation) over the period Jan 2003-April 2013.

	Fund Returns (%)		Asset Allocation Patterns			
			Survey Sample	FinLit Index=0-1	FinLit Index=2-3	FinLit Index=4-5
Fund	*Monthly mean return*	*Std. Dev.*	*%*	*%*	*%*	*%*
Government Securities Fund	0.2	*0.4*	3.9	6.4	5.3	3.4
TIPS Index Fund	0.4	*1.9*	3.2	5.5	2.7	3.3
Interest Income fund	0.4	*0.1*	6.6	9.8	8.7	5.9
Bond Index Fund	0.4	*1.0*	3.1	2.6	3.1	3.1
2014 Select Maturity Bond Fund	0.1	*0.1*	5.8	7.2	7.6	5.2
2016 Select Maturity Bond Fund	0.3	*0.5*	5.0	7.7	6.9	4.4
2018 Select Maturity Bond Fund	0.4	*1.1*	5.6	7.5	7.1	5.1
2020 Select Maturity Bond Fund	0.5	*1.6*	0.0	0.0	0.0	0.0
Equity Index Fund	0.9	*4.3*	25.2	15.5	20.5	26.9
International Equity Fund	0.9	*6.0*	5.5	3.5	4.1	6.0
Emerging Markets Equity Fund	1.4	*6.7*	0.8	0.2	0.3	0.9
Small Company Equity Fund	1.1	*5.4*	6.0	2.6	3.8	6.7
Conservative Asset Allocation Fund	0.5	*1.4*	8.9	11.7	9.8	8.5
Moderate Asset Allocation Fund	0.7	*2.4*	11.2	11.0	12.7	10.8
Aggressive Asset Allocation Fund	0.8	*3.8*	5.8	6.9	5.4	5.9
REIT Index Fund	1.1	*7.2*	3.5	1.9	2.1	4.0
% equity holdings/participant			*55.4*	*42.6*	*47.8*	*59.6*

Table 4. Descriptive Statistics: Participants' Number of Funds Held and Pension Performance

This Table reports the average number of funds held, equity fraction, monthly excess return, standard deviation, and nonsystematic risk share (%NSR; see text) across participants of different types, as of April 2013. Survey nonrespondents were employees who contributed to their 401(k) plan but did not respond to the survey. Survey respondents contributed to their 401(k) plan and responded to the Financial Literacy survey. FinLit Index is derived by summing correct answers in Table 2.

A. Mean Values by Type of Employee

	Survey Nonparticipants	Survey Participants	Low Fin. Lit. Index (0-1)	Med. Fin. Lit. Index (2-3)	High Fin. Lit. Index (4-5)
Number of funds	3.81	4.14	4.25	4.12	4.15
Equity allocation (%)	56.39	58.01	44.30	48.82	62.99
Monthly excess returns (%)	0.51	0.53	0.46	0.49	0.54
Monthly st.dev. (%)	3.77	3.91	3.03	3.31	4.23
%NSR	8.48	8.53	12.03	10.28	7.51
N	13,362	2,706	132	778	1,796

B. Tests for Differences in Means by Employee Type

	Diff. (Part.-Nonpart.)	Diff. (Mid-LowFin.Lit)	Diff. (Hi-Low Fin.Lit.)	Diff. (Hi-Mid Fin. Lit.)
Number of funds	0.33 ***	-0.13	-0.10	0.03
Equity allocation (%)	1.62 **	4.52	18.69 ***	14.17 ***
Monthly excess returns	0.02 ***	0.03 **	0.08 ***	0.05 ***
Monthly st.dev. (%)	0.14 ***	0.28	1.20 ***	0.92 ***
%NSR	0.05	-1.75	-4.52 ***	-2.77 ***

Note: Two-sided tests; *** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Table 5. Multivariate Models of Portfolio Outcomes and Financial Knowledge

This Table reports linear regression estimates of factors associated with the average fraction of retirement assets each participant held in equity, monthly expected excess returns and standard deviations, and idiosyncratic risk shares, as of April 2013. Standard errors in brackets. The sample consists of 401(k) plan contributors with a Financial Literacy Index derived from correct answers as in Table 2; the reference category is Low Financial Literacy (=0-1 correct). All models also control for region-specific fixed effects and missing data dummies; N=2.763. (For variable descriptions see Appendix Table 1.)

	Equity allocation	Monthly excess return	Monthly st.dev.	%NSR
	1	2	3	4
Mid Fin. Literacy Index (2-3)	2.506	0.012	0.118	-1.164
	[2.781]	[0.011]	[0.159]	[0.818]
High Fin. Literacy index (4-5)	11.522 ***	0.035 ***	0.696 ***	-1.708 **
	[2.729]	[0.011]	[0.157]	[0.801]
Age	-0.627 ***	-0.001 ***	-0.036 ***	0.084 ***
	[0.059]	[0.000]	[0.003]	[0.016]
Male	4.027 ***	0.019 ***	0.294 ***	0.277
	[1.103]	[0.004]	[0.065]	[0.298]
Married	2.089 *	0.007	0.103	-0.457
	[1.204]	[0.005]	[0.070]	[0.339]
Salary ($10k)	0.292 *	0.000	0.014	-0.045
	[0.162]	[0.001]	[0.010]	[0.043]
Total balance ($100k)	1.881 ***	0.006 ***	0.096 ***	-0.427 ***
	[0.312]	[0.001]	[0.019]	[0.082]
Tenure	-0.558 ***	-0.001 **	-0.028 ***	0.124 ***
	[0.070]	[0.000]	[0.004]	[0.018]
N	2,763	2,763	2,763	2,763
R-square	0.157	0.058	0.148	0.058
Mean of dep var (%)	61.347	0.618	4.069	6.680
St.dev of dep var (%)	29.656	0.117	1.737	7.789

Notes: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level.

Table 6. Multivariate Models of Portfolio Outcomes and Financial Literacy with Heckit Sample Selection Correction

The first column reports coefficient estimates from a Probit sample selection model for responding to the Financial Literacy Survey. Subsequent columns replicate the multivariate regressions for the four dependent variables of interest in Table 5 (as of April 2013), along with the Lambda that corrects for sample selection. Standard errors in brackets. The reference category in the last four columns is Low Financial Literacy (=0-1 correct). All models also control for region-specific fixed effects and missing data dummies.

	Took FinLit Survey	Equity allocation	Monthly excess return	Monthly st.dev.	%NSR
	Probit	1	2	3	4
Mid Fin. Literacy Index (2-3)		3.685	0.025 **	0.222	-1.577
		[2.723]	[0.012]	[0.166]	[1.313]
High Fin. Literacy index (4-5)		14.055 ***	0.063 ***	0.915 ***	-3.424 ***
		[2.673]	[0.012]	[0.163]	[1.273]
Age	0.019 ***	-4.804 ***	-0.011 ***	-0.306 ***	0.824 **
	[0.001]	[0.815]	[0.004]	[0.051]	[0.336]
Male	-0.008	5.560 ***	0.025 ***	0.427 ***	0.120
	[0.025]	[1.191]	[0.005]	[0.075]	[0.444]
Married	0.027	-3.967 **	0.002	-0.272 **	-0.033
	[0.027]	[1.812]	[0.008]	[0.114]	[0.730]
Salary ($10k)	0.009 ***	-1.723 ***	-0.004 **	-0.114 ***	0.242
	[0.003]	[0.447]	[0.002]	[0.028]	[0.196]
Total balance ($100k)	0.036 ***	-5.888 ***	-0.011 *	-0.386 ***	0.831
	[0.007]	[1.429]	[0.007]	[0.091]	[0.570]
Tenure	-0.001	-0.336 ***	-0.001 ***	-0.019 ***	0.157 ***
	[0.002]	[0.076]	[0.000]	[0.005]	[0.031]
Lambda		-281.730 ***	-0.635 **	-18.032 ***	47.718 **
		[55.068]	[0.254]	[3.483]	[22.754]
N	16,068	2,706	2,706	2,706	2,706
R-square	0.073	0.163	0.090	0.158	0.076
Mean of dep var (%)	0.168	58.007	0.525	3.910	8.526
St.dev of dep var (%)	0.374	30.610	0.135	1.944	11.323

Note: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level.

Table 7. Inverse-Probability Weighting Models of Portfolio Outcomes and Financial Knowledge

This Table reports the estimated effects of the Average Treatment Effect (ATE) for the high financial literacy group for the four portfolio outcome variables of interest in Table 5 (as of April 2013). The inverse-probability weighting model computes the ATE level and percent for being in the high financial literacy group. Standard errors in brackets. Models also control for variables included in Table 5.

	Equity allocation	Monthly excess return	Monthly st.dev.	%NSR
	1	*2*	*3*	*4*
ATE	7.136 ***	0.033 ***	0.472 ***	-1.571 ***
	[0.806]	[0.003]	[0.053]	[0.305]
ATE (%)	0.128 ***	0.065 ***	0.126 ***	-0.182 ***
	[0.015]	[0.006]	[0.014]	[0.035]

Note: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level.

Table 8. Changes in Portfolio Outcomes Pre/Post Financial Literacy Survey (April vs December 2013)

	Δ Equity allocation		Δ Monthly excess return		Δ Monthly st.dev.		Δ %NSR	
	1		2		3		4	
Fin Lit survey participation	0.664	*	0.023	***	-0.037		-0.206	
	[0.379]		[0.006]		[0.024]		[0.168]	
Age	0.012		-0.005	***	0.008	***	-0.011	*
	[0.015]		[0.000]		[0.001]		[0.006]	
Male	0.278		0.044	***	-0.059	***	-0.065	
	[0.255]		[0.004]		[0.016]		[0.113]	
Married	-0.043		0.013	***	-0.002		0.093	
	[0.277]		[0.005]		[0.017]		[0.124]	
Ln(Salary)	0.031		0.118	***	-0.223	***	-0.054	
	[0.330]		[0.006]		[0.021]		[0.147]	
Total balance ($100k)	0.010		0.004	***	-0.009		0.059	
	[0.094]		[0.002]		[0.006]		[0.044]	
Tenure	0.012		-0.002	***	0.009	***	-0.048	***
	[0.019]		[0.000]		[0.001]		[0.009]	
Contribution % of salary	0.097	***	0.004	***	-0.001		-0.043	***
	[0.031]		[0.001]		[0.002]		[0.015]	
N	14,736		14,736		14,736		14,736	
R-square	0.003		0.090		0.029		0.009	
Mean of dep var (%)	3.390		0.600		-0.478		0.470	
St.dev of dep var (%)	15.321		0.275		0.971		6.656	

Note: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level. Average fund returns during prior 60 months used to predict expected returns.

Table 9. Changes in Portfolio Factor Weightings Pre-Post Financial Literacy Survey (April vs December 2013)

	Δβ(Mkt)	Δβ(SmB)	Δβ(HmL)	Δβ(UmD)	Δβ(Term)	Δβ(Def)
	1	*2*	*3*	*4*	*5*	*6*
Fin Lit survey participation	0.008 ***	0.001	0.000	0.001 *	-0.007 ***	-0.002 **
	[0.003]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]
Age	0.000	0.000	0.000	0.000	0.000 ***	0.000 **
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Male	0.007 ***	0.005 ***	-0.001	0.002 ***	-0.007 ***	-0.005 ***
	[0.002]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
Married	-0.001	0.001	0.001	0.000	0.001	0.001
	[0.002]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
Ln(Salary)	0.001	0.001	0.002 **	0.002 ***	-0.011 ***	-0.006 ***
	[0.003]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
Total balance ($100k)	-0.001	0.000	0.000	0.000	0.000	0.000
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tenure	0.001 ***	0.000	0.000 ***	0.000 ***	0.001 ***	0.000 ***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Contribution % of salary	0.001 ***	0.000 ***	0.000	0.000 ***	-0.001 ***	0.000 ***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
N	14,736	14,736	14,736	14,736	14,736	14,736
R-square	0.011	0.005	0.004	0.012	0.049	0.020
Mean of dep var	4.265%	1.172%	-0.065%	0.063%	-0.145%	-0.002%
St.dev of dep var	12.382%	6.074%	4.884%	2.127%	4.884%	4.593%

Coefficients on factors estimated using returns during prior 60 months. The portfolio factors are defined as follows (as per Fama French 1993):

   Mkt: The excess return on the market, or the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates);
   SmB: The performance of small stocks relative to big stocks;
   HmL: The performance of value stocks relative to growth stocks;
   UmD: The Fama-French up-minus-down factor;
   Term: The difference between the monthly long-term government bond return (from Ibbotson Associates) and the one-month Treasury bill rate measured at the end of the previous month (from the Center for Research in Security Prices, CRSP);
   Def: The difference between the return on a market portfolio of long-term corporate bonds (the Composite portfolio on the corporate bond module of Ibbotson Associates) and the long-term government bond

Note: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level.

Appendix Table 1. Descriptive Statistics for Variables in Table 5

This Table reports descriptive statistics for dependent and explanatory variables used in models reported in Table 5.

	Mean	Sd. Dev.	Min	Max
Equity allocation (%)	58.01	30.61	0.00	100.00
Monthly excess return (%)	0.53	0.13	0.11	1.03
Monthly st.dev. (%)	3.91	1.94	0.19	9.41
%NSR (%)	8.53	11.32	0.04	75.49
Low Fin. Literacy Index (0-1)	0.05	0.22	0	1
Low Fin. Literacy Index (2-3)	0.29	0.45	0	1
High Fin. Literacy index (4-5)	0.66	0.47	0	1
Age	48.45	10.18	21	77
Male	0.57	0.50	0	1
Married	0.70	0.46	0	1
Salary ($10k)	10.95	5.11	2.94	42.41
Total balance ($100k)	2.44	2.86	0	29.63
Tenure	14.57	11.37	0	46
Self-assessment score	4.70	1.28	1	7
Allocating plan investments	4.04	1.57	1	7

Appendix Table 2. Multivariate Models of Portfolio Outcomes and Financial Knowledge with dummies for Age and Tenure *(instead of continuous variables).*

This Table reports coefficient estimates from multivariate regressions for the same four dependent variables used in Table 4, along with dummy variables for Age and Tenure (instead of continuous variables). The sample consists of 401(k) plan contributors with a Financial Literacy Index derived from correct answers as in Table 2; the reference category is Low Financial Literacy (=0-1 correct). All models also control for region-specific fixed effects and missing data dummies. Standard errors in brackets.

	Equity allocation	Monthly excess return	Monthly st.dev.	%NSR
	1	2	3	4
Mid Fin. Literacy Index (2-3)	4.219	0.026 **	0.249	-1.802
	[2.758]	[0.012]	[0.168]	[1.321]
High Fin. Literacy index (4-5)	14.583 ***	0.064 ***	0.935 ***	-3.689 ***
	[2.730]	[0.012]	[0.166]	[1.275]
Age>=50	-12.668 ***	-0.025 ***	-0.772 ***	2.239 ***
	[1.221]	[0.006]	[0.078]	[0.463]
Male	4.120 ***	0.022 ***	0.334 ***	0.341
	[1.160]	[0.005]	[0.074]	[0.434]
Married	1.174	0.013 **	0.059	-0.828
	[1.268]	[0.006]	[0.080]	[0.512]
Ln(Salary)	5.496 ***	0.015 *	0.315 ***	-1.821 ***
	[1.796]	[0.008]	[0.115]	[0.697]
Total balance ($100k)	0.414	0.002 *	0.017	-0.197 *
	[0.306]	[0.001]	[0.020]	[0.118]
Tenure>=10	-8.734 ***	-0.037 ***	-0.524 ***	3.49 ***
	[1.370]	[0.006]	[0.087]	[0.514]
Contribution % of salary	0.300 ***	0.001 *	0.025 ***	0.039
	[0.114]	[0.001]	[0.007]	[0.045]
N	2,706	2,706	2,706	2,706
R-square	0.135	0.082	0.134	0.065
Mean of dep var (%)	58.007	0.525	3.910	8.526
St.dev of dep var (%)	30.610	0.135	1.944	11.323

Notes: * Significant at 0.10 level, ** Significant at 0.05 level, *** Significant at 0.01 level. Regional controls also included.